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Functional description | EN

TF5200 | TwinCAT 3 CNC

Jog of path

12/18/2023 | Version: 1.16
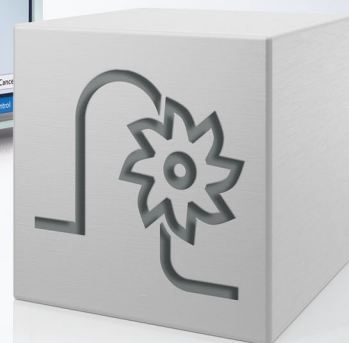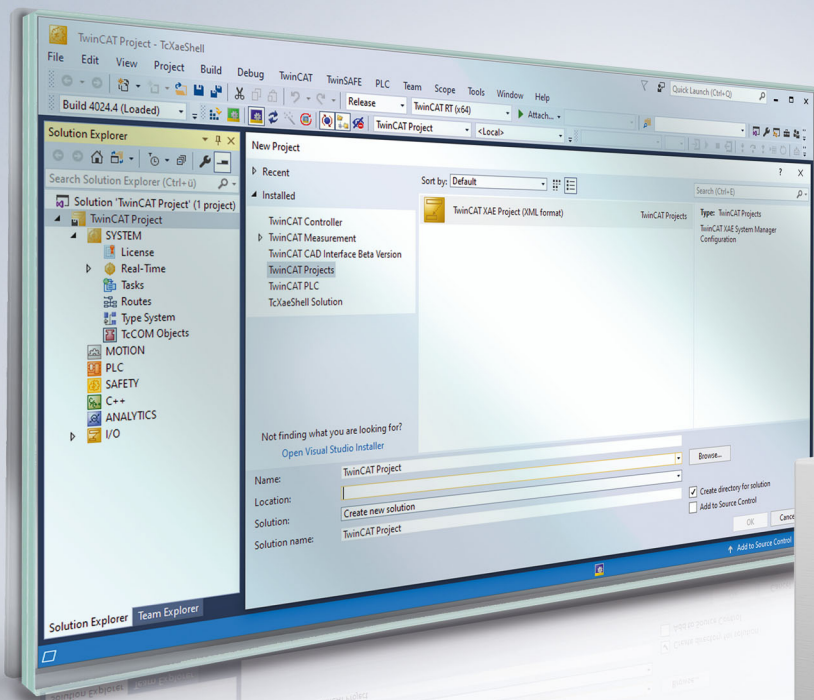
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It is essential that the documentation and the following notes and explanations are followed when installing and commissioning the components.

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This documentation uses the following icons next to the safety instruction and the associated text. Please read the (safety) instructions carefully and comply with them at all times.

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1. Indicates an action.
   ⇨ Indicates an action statement.

⚠ DANGER
Acute danger to life!
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If you fail to comply with the safety instruction next to this icon, it may result in personal injury or damage to machines.

NOTICE
Restriction or error
This icon describes restrictions or warns of errors.

ℹ Tips and other notes

This icon indicates information to assist in general understanding or to provide additional information.

General example

Example that clarifies the text.

NC programming example

Programming example (complete NC program or program sequence) of the described function or NC command.

ℹ Specific version information

Optional or restricted function. The availability of this function depends on the configuration and the scope of the version.

Version: 1.16

Table of contents

List of figures

1   Overview

Task

This function permits a pause in the machining process to be made in a channel and to move the same physical axes from a second channel.

This is referred to as a channel switchover.

Properties

Switching over a channel to react to events which require any path motion, e.g. changing a torch in a flame or gas cutting operation.

Parameter

An auxiliary channel is required here; it must contain the parameters [▶ 10] for the auxiliary axes.

Mandatory note on references to other documents

For the sake of clarity, links to other documents and parameters are abbreviated, e.g. [PROG] for the Programming Manual or P-AXIS-00001 for an axis parameter.

For technical reasons, these links only function in the Online Help (HTML5, CHM) but not in pdf files since pdfs do not support cross-linking.

2   Description

Request

The user has the frequent request to interrupt a running program in order to insert a path motion and then continue the program after the interruption.

Inserting a path motion can be implemented by using an "auxiliary channel". In this document, an "auxiliary channel" is referred to as a jog of path channel.

A jog of path channel contains linked axes which are connected to the same physical axes as the axes in the actual channel.

Switchover

Channels are switched over by the PLC. Exclusive access of a channel to physical axes is controlled by a control unit provided for each channel.
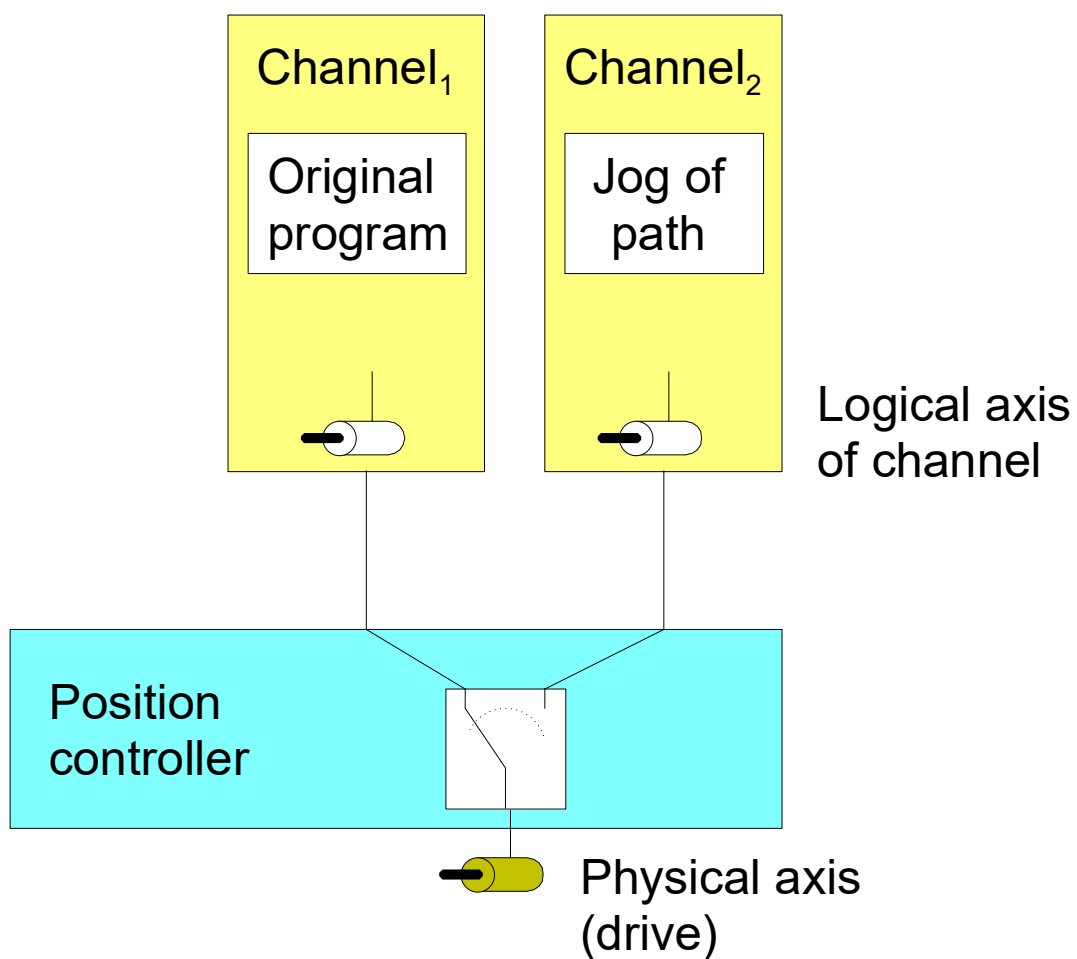

Fig. 1: Moving axes by different channels

Position offset

When an axis is moved by an inserted path motion, it also retains the offset in the original channel as soon as this channel regains access to the axis.

If this is not required, the user must ensure that the axes are returned to the position they were in before the interruption.

i **Licensing note**

No additional channel license is required for jog of path channels containing only axes which are linked to physical axes of other channels.

The parameter P-CHAN-00306 [▶ 20] must be set for this.

i **Suspending axes is not possible when a channel is in an error state, for example, due to a programming error or when a channel axis error.**

Before suspending the channel axes, remove the error state and reset the channel.

2.1 Configuring axes and channels

Axes

In order to interrupt a machining process and move an axis by another channel, an additional logical axis (e.g. Log. AchsNr. 11) is configured and linked to an existing physical axis (e.g. Log. AchsNr. 1). The link is specified in the axis parameter kopf.link_to (P-AXIS-00101).

A clone operation takes over all data from the original axis except for the new axis number. This is executed by the axis parameter kopf.clone_of (P-AXIS-00040) by specifying the axis number of the axis whose axis parameter list is to be copied.

```
kopf.achs_nr                          11
kopf.link_to            1
kopf.clone_of           1
```

Channels

The channels are configured with the logical axes as usual.

Channel 1 contains axes 1 to 3 as the main axes

```
gruppe[0].achs_anzahl       3
gruppe[0].achse[0].log_achs_nr    1
gruppe[0].achse[0].bezeichnung    X
gruppe[0].achse[1].log_achs_nr    2
gruppe[0].achse[1].bezeichnung    Y
gruppe[0].achse[2].log_achs_nr    3
gruppe[0].achse[2].bezeichnung    Z
```

Channel 2 represents the auxiliary channel and contains axes 11 to 13 as main axes

```
gruppe[0].achs_anzahl       3
gruppe[0].achse[0].log_achs_nr    11
gruppe[0].achse[0].bezeichnung    X
gruppe[0].achse[1].log_achs_nr    12
gruppe[0].achse[1].bezeichnung    Y
gruppe[0].achse[2].log_achs_nr    13
gruppe[0].achse[2].bezeichnung    Z
```

The parameter P-CHAN-00306 [▶ 20] is set in the clone channel for checking the license.

```
jog_of_path_only            1
```

Channel₁
name = X
nr = 1

Channel₂
name = X
nr = 11

Axis
nr = 1

Channel₁

Original
program

Channel₂

Jog of
path

1

11

Axis
nr = 11
clone of = 1
link to = 1

Logical axis
of channel

Position
controller

1

Physical axis
(drive interface)
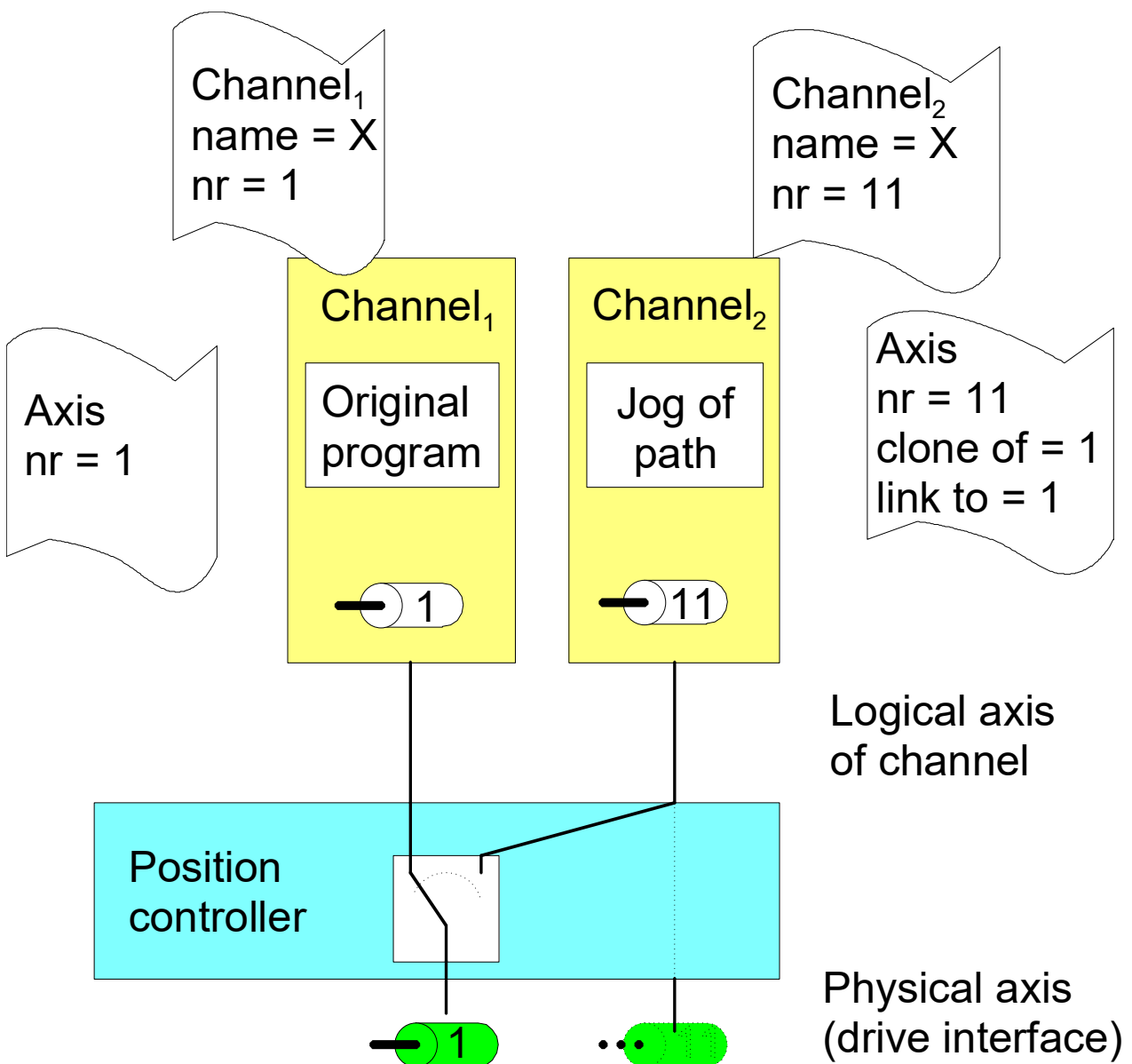
Fig. 2: Configuring axes

Cloned axis

To create a cloned axis, the axis must first already exist and be initialised before its axis parameter list can be used as a template for the cloned axis. A cloning process involves taking over the parameters of the axis which acts as a template only once. Any subsequent change in axis parameters has no effect on the cloned data set. It only modifies or overwrites the individual axis parameters.

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Default list | Master list | Clone list

System start up

Default values

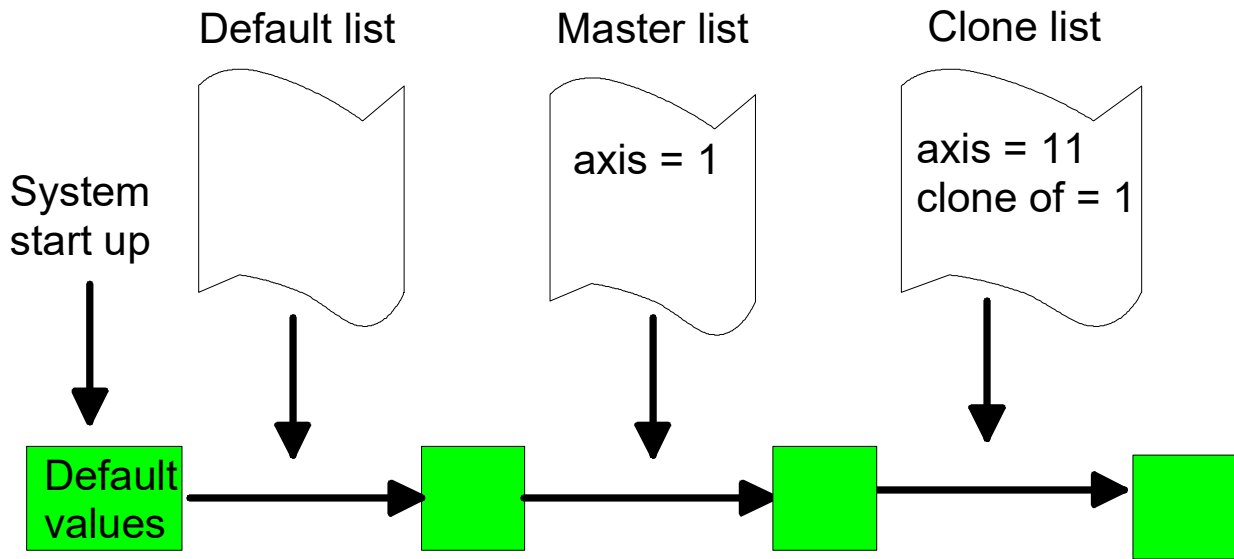axis = 1

axis = 11
clone of = 1

Fig. 3: Initialising a cloned axis

ℹ The specified clone reference cannot be changed after the first initialisation.

ℹ If there is no master axis of the clone, the error messages ID 70172 and P- ID 50462 are issued and a cloned axis is created without a real cloning process.

2.2   Switchover sequence

Access to axes

As long as the output of a channel is not suspended, the physical axes are linked to the logical axes of the channel. If a second channel requests the same physical axes as those of the first channel, the system waits automatically until the first channel has suspended its output.

If axes move in the channel which suspends axis access, these axes are stopped by a feedhold triggered internally in the NC kernel.

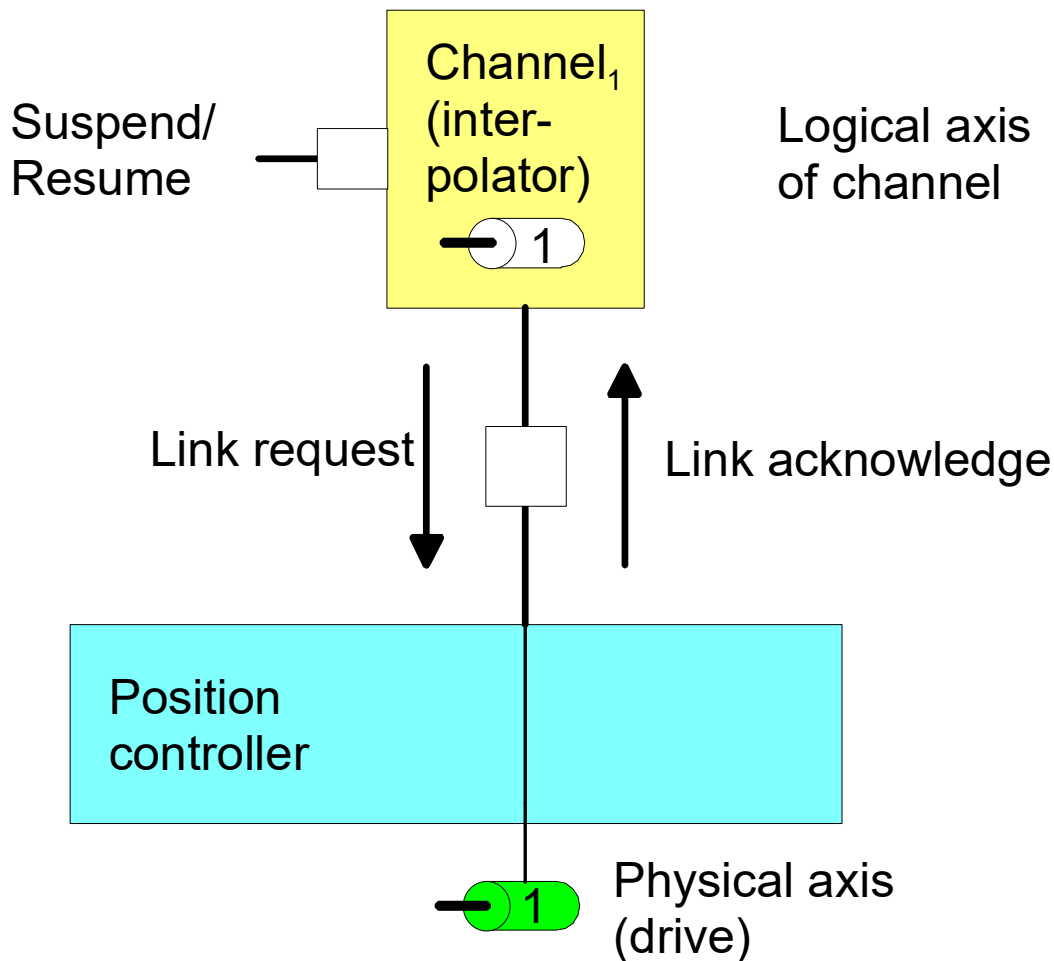Fig. 4: Handshake between axes when access to a channel axis is suspended

> **i** If access to a physical axis is configured by two (or several) channels, one channel is not given access to the axes until all other channels have suspended their access.

2.3   Positions off set

The link between a physical and a logical axis can be changed by an active program with the axes at standstill. After axis output is suspended, the axes can be moved by another channel.

After an axis is returned to the original channel, the commanded position in the channel (command position) and the physical position (active position) may be different. This position offset is cleared at program start and with NC commands (such as #CHANNEL INIT[], deselection of G200 etc.) which cause a position adjustment in the channel.

Therefore, the commanded position in the channel corresponds to the physical set position of the axis (command position = active position).

i   The position offsets of the axes are cleared when the channel is initialised or at program start.

Offset = command position (of active link) – active position

Channel₁ Channel with subscript 1

Figure content with labels:
- Channel$_1$ / Original program / 1
- Channel$_2$ / Jog of path / 11
- Logical axis of channel
- Command position$_1$
- Command position$_2$
- Active position
- Position controller
- Physical axis (drive) / 1
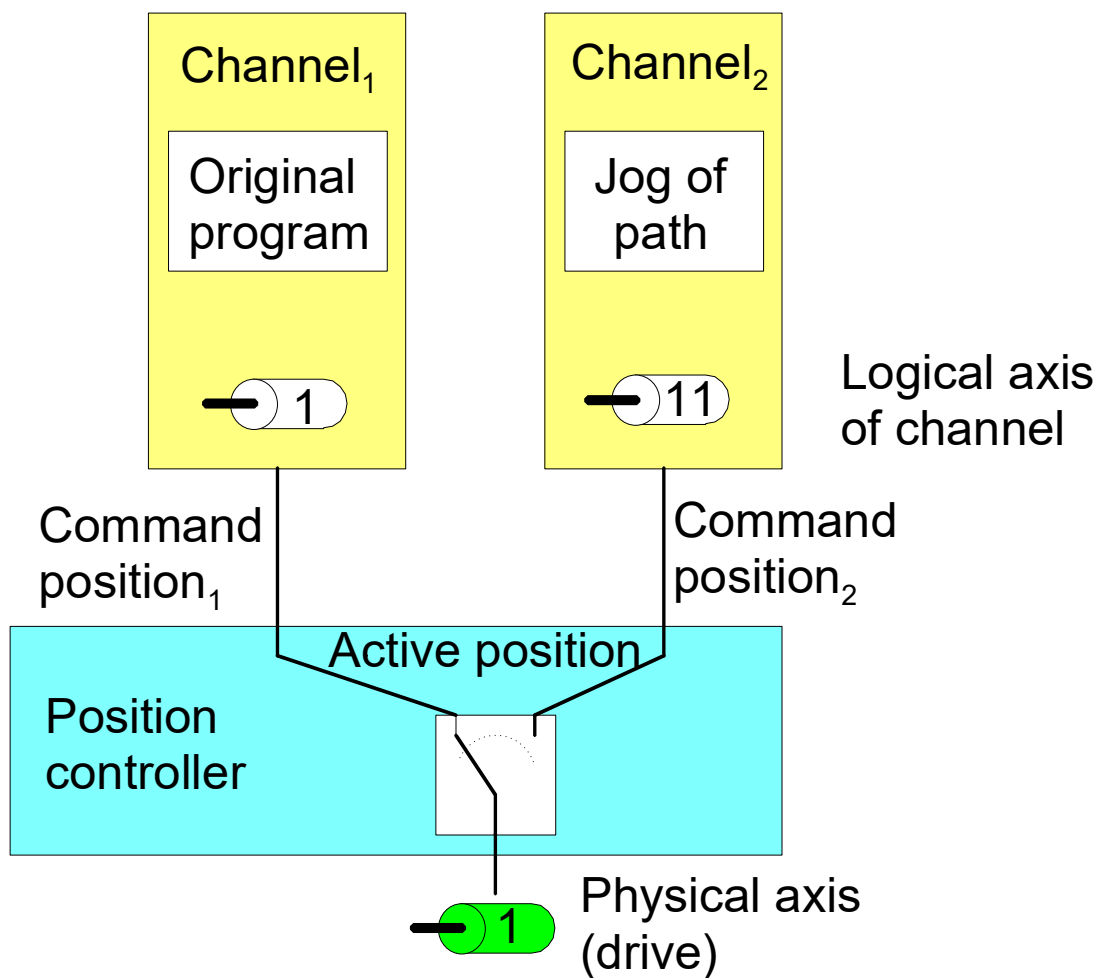
Fig. 5: Position offset by another channel

Manual block in both channels

Axis 1 of channel 1 and axis 11 of channel 2 are linked to the same physical axis. In each channel, a different manual block (without M30) is started and the channels are suspended one after another.

Channel 1: Command position (command position)	Channel 2: Command position (command position)	Physical axis position (active position)	Offset channel 1	Offset channel 2
0 -> 50		0 -> 50	0	0
	50 -> 15	50 -> 15	0	0
50 -> 80		15 -> 45	35	-30
	15 -> 0	45 -> 30	50	-30

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2.4 Application examples

configuration

2 channels are configured. In channel 1, the Y axis is configured with log axis no. 2 and in channel 2, the cloned axis is configured with the log. axis no. 11.

Configuration of an additional logical axis 11 for physical axis number 2

```
kopf.achs_nr          11
kopf.link_to          2
kopf.clone_of         2
```

Actions

1. Start manual block "G01 G90 X20 Y20 F100" in 1.Kanal 1
2. Set "Suspend-Output" in the channel 1 to 1
3. Clear "Suspend-Output" in the other channel 2
4. Start manual block "G91 Y10" in channel 2 and wait until it ends its execution
5. Clear "Suspend-Output" in channel 1
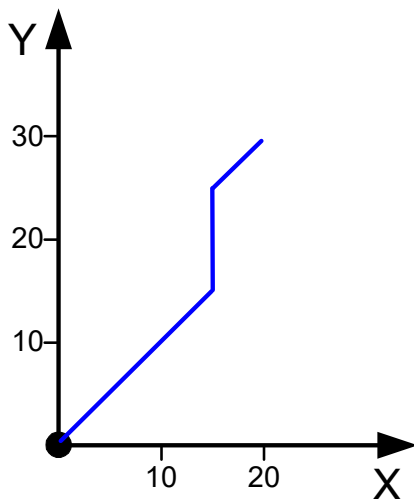6. Set "Suspend-Output" in channel 2

Fig. 6: Position sequence of the example

Alternatively, a motion can be started in manual mode in channel 2 instead of the manual block.

3   PLC interface

The PLC interface provides control units to switch channel access to the axes and to display the axes.

Interrupt output of command values to real axes	
Description	This interrupts the output of NC channel command values to physical axes. The NC channel is stopped and assignment to the real axes is disabled.
	Physical axes can then be requested and moved by another channel. A different logical axis can be linked to a physical axis here.
	After clearing this interruption, the axes can be requested again and the original channel continues its motion.
Data type	MC_CONTROL_BOOL_UNIT, see description Control unit
Access	PLC reads request_r + state_r and writes command_w + enable_w
ST Path	gpCh[channel_idx]^.bahn_mc_control.suspend_axis_output
Commanded, requested and return values	
ST Element	**.command_w**
	.request_r
	.state_r
Data type	BOOL
Value range	[TRUE, FALSE]
Redirection	
ST element	**.enable_w**

Position offset	
Description	Display of the current offset of the absolute position between the position controller axis (real physical axis) and the interpolator axis (logical axis) currently linked in the axis coordinate system.
	The display here shows an offset between the interpolator position and the position controller position caused by the use of functions such as "jog of path" (see [FCT-C15 [▶ 8]].
	The offset displayed contains no offsets caused by zero offsets, for example.
Signal flow	CNC → PLC
ST path	gpAx[*axis_idx*]^.lr_state.**position_offset_r**
Data type	DINT
Unit	0.1 µm
Access	PLC is reading

Axis supply	
Description	The command of the physical axes is executed by the logical axis specified in the NC channel.
Signal flow	CNC → PLC
ST path	gpAx[*axis_idx*]^.lr_state.**link_to_ipo_r**
Data type	UINT
Value range	[= 0 – not linked, > 0 – logical axis number]
Access	PLC is reading

Axis assignment	
Description	The display shows the physical axes to which the commanded values of the logical axes are of the channel output.
Signal flow	CNC → PLC
ST path	gpAx[*axis_idx*]^.ipo_state.**link_to_lr**

Data type	UINT
Value range	[= 0 – not linked, > 0 – logical axis number]
Access	PLC is reading

4 HMI interface

The current state of an axis can be read by the following channel-specific CNC objects of the axis.

- requested_link_to_physical_axis [▶ 21]
- actual_link_to_physical_axis [▶ 21]
- link_state [▶ 21]

In the example below, channel 1 is waiting for the acknowledgement of the request for the second axis. This can be seen by the CNC object "link_state" which has the value 2.

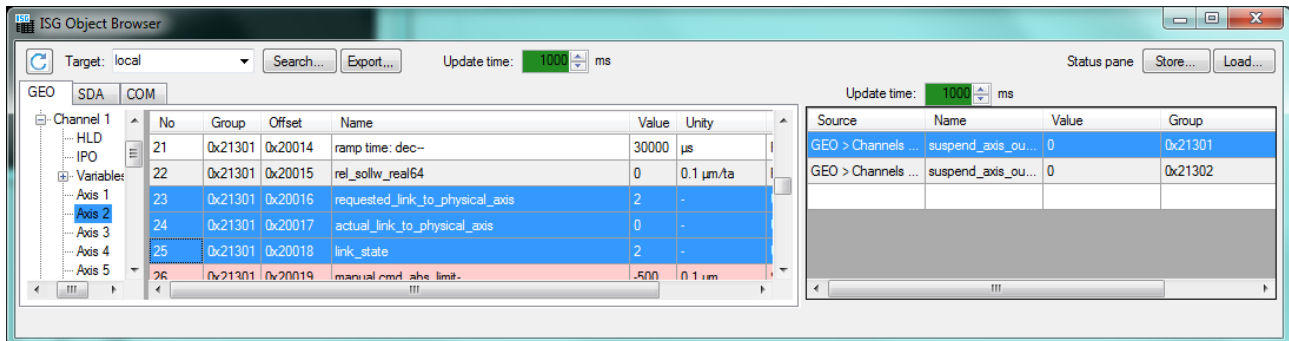The command value suppression is not active in either channel.

Fig. 7: Waiting for axis acknowledgement.

5 Parameter

5.1 Overview

ID	Parameter	Meaning
P-AXIS-00040	kopf.clone_of	Axis copy
P-AXIS-00101	kopf.link_to	Link to the physical axis
P-AXIS-00483	kenngr.auto_release_of_axis_link	Enabling of IPO-LR interface after axis release
P-CHAN-00306	jog_of_path_only	License check of the clone channel

5.2 Description

Channel parameters

P-CHAN-00306	**Checking the license in the clone channel**
Description	This parameter checks the license in the clone channel. When this parameter is set, a check is made during start-up whether all the axes configured in the channel are clone axes. Only then is this channel license-free. The check is also made at RESET and axis exchange. If an axis is not a clone axis, an error message is output.
Parameter	jog_of_path_only
Data type	BOOLEAN
Data range	0/1
Dimension	----
Default value	0
Remarks	This parameter allows the 2nd channel to be used as a Jog-Of-Path channel even with a single-channel license. The parameter is available as of Build V3.1.3037.17.

Axis parameter

P-AXIS-00040	**Mapping of parameters of an existing axis for default configuration.**	
Description	For easier configuration, an axis could be a copy (clone) of another axis. This means, when the axis is initialised, the clone just uses the data of its master as template. The clone merely has to specify the differences to its master in the parameter list.	
Parameter	kopf.clone_of	
Data type	UNS16	
Data range	0 < clone_of < MAX(UNS16)	
Axis types	T, R, S	
Dimension	T: ----	R,S: ----
Default value	0	
drive types.	----	
Remarks		

P-AXIS-00101	**Linking an interpolator output to a specific physical axis.**
Description	The parameter requests a link between the logical axis of the interpolator and the axis of the position controller (drive). If you attempt to link more than one logical axis to the same drive, all the other axes must wait until this link is temporarily interrupted by a command and released for a new connection.
Parameter	kopf.link_to

Data type	UNS16	
Data range	0 < link_to < MAX(UNS16)	
Axis types	T, R, S	
Dimension	T: ----	R,S: ----
Default value	0	
drive types.	----	
Remarks		

P-AXIS-00483	**Enabling of IPO-LR interface after axis release**	
Description	A drive can be connected as part of the functionality 'Jog of Path' with more than one axis (link_to, P-AXIS-00101). Here the drive is supplied via the axis-specific interface between interpolator and position controller (see [FCT-C15 [▶ 8]]).	
	If this type of linked axis leaves the interpolator after an axis release, and a SUSPEND command is executed in this channel, the interface is not enabled. Another channel that possibly requests this axis has no access to this interface and stops.	
	By setting the parameter 'kenngr.auto_release_of_axis_link' this interface is automatically enabled when the axis is released and a system stop can be avoided.	
Parameter	kenngr.auto_release_of_axis_link	
Data type	BOOLEAN	
Data range	0/1	
Axis types	T, R, S	
Dimension	T: ----	R,S: ----
Default value	0	
drive types.	----	
Remarks		

5.3 CNC objects

Name	requested_link_to_physical_axis				
Description	This object shows the number of the requested physical axis.				
	(used for channel switchover)				
Task	GEO (Port 551)				
Index group	0x12130<C_{ID}>	Index offset		0x<A_{ID}>0016	
Data type	UNS16	Length		2	
Attributes	read	Unit		[-]	
Remarks					

Name	actual_link_to_physical_axis				
Description	This object shows the currently assigned physical axis.				
	(used for channel switchover)				
Task	GEO (Port 551)				
Index group	0x12130<C_{ID}>	Index offset		0x<A_{ID}>0017	
Data type	UNS16	Length		2	
Attributes	read	Unit		[-]	
Remarks					

Name	link_state
Description	This object shows the state of the axis request, i.e. the assignment of logical and physical axes:
	0 : Axis link already existing

	1 : Physical axis is requested by the position controller				
	2 : Waiting for acknowledgement of the physical axis from the position controller				
	(used for channel switchover)				
Task	GEO (Port 551)				
Index group	0x12130<C_{ID}>	**Index offset**		0x<A_{ID}>0018	
Data type	UNS32	**Length**		4	
Attributes	read	**Unit**		[-]	
Remarks					

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